Water Sources for Public-Supply Wells in Three Fractured-Bedrock Aquifer Systems in Massachusetts

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Abstract

Fractured-bedrock aquifer systems in West Newbury, Maynard, and Paxton, Massachusetts, were studied to advance methods of data collection and analysis for delineating contributing areas to public-supply wells completed in fractured rock and for determining the effects of pumping on streams and wetlands. Contributing areas, as defined for this study, include all areas through which ground water flows from recharge areas to wells.

In West Newbury, exploratory public-supply wells at two locations were completed in phyllite of the Eliot Formation. Aquifer testing indicated that subhorizontal and steeply dipping fractures that parallel two sets of foliation form elongated transmissive zones in the bedrock aquifer near the two well locations and also form a vertical hydraulic connection to surficial materials consisting of till at one location and marine clay at the other location. Recharge to bedrock is largely through a thin veneer of till over bedrock, but leakage through thick drumlin tills also recharges bedrock. Simulated contributing areas for the three supply wells pumped at a combined rate of 251 gallons per minute encompass about 1.3 square miles and extend to ground-water divides within most of a subbasin of the Artichoke River.

In Maynard, three exploratory public-supply wells were completed in coarse-grained schist of the Nashoba Formation. Aquifer testing indicated that a dense network of fractures in bedrock forms a laterally extensive transmissive zone in bedrock that is well connected vertically to surficial materials consisting of sandy till, lacustrine silts, sand and gravel, and wetland deposits. The simulated contributing area for the three supply wells pumped at a combined rate of 780 gallons per minute encompasses about 1.8 square miles of the Fort Pond Brook drainage area.

In Paxton, three existing supply wells are completed in granofels and schist of the Paxton and Littleton Formation. Aquifer testing demonstrated that a shallow bedrock well completed to a depth of 150 feet is closely connected hydraulically to overlying till. Two deep wells, however, receive much of their water from fractures at depths below 500 feet. Ground-water flow in bedrock appears to be mostly through parting fractures along a foliation set that dips gently (10 degrees) eastward. These parting fractures at depth are poorly connected vertically to shallow bedrock and till. Simulated contributing areas for the three bedrock supply wells and one dug well pumped at a combined rate of 148 gallons per minute encompass 3.0 square miles or more.

Activities that provide useful information for delineations of contributing areas to wells in fractured rock include characterization of ductile structures and fractures in bedrock outcrops and boreholes, long-term observation of water levels in wells completed in bedrock and surficial materials, extended aquifer tests of 7 days or more, and water-level observations during aquifer testing in residential supply wells and piezometers completed in surficial materials. Recharge rates and potential leakage rates from surficial materials to bedrock aquifers stressed by pumping are, in general, poorly defined and are major sources of uncertainty for accurate delineation of contributing areas to public-supply wells.

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